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Publication date:
2019

Document Version
Publisher's PDF, also known as Version of record

MOF-graphene composite with long order-disorder process for high-performance lithium ion batteries

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Abstract

The metal-organic frameworks (MOFs) have gained considerable attention owing to their unique structures with tunable three-dimensional porous frameworks and numerous applications. The large surface area and great porosity make MOFs a potential electrode material for lithium-ion batteries (LIBs). However, the impact of lithiation/delithiation on structures of MOFs have been investigated to very limited extent. In this presentation, we report our initial advances in understanding the relationship between the structure of MOFs and the electrochemical performances. We prepared Al-MOF and combined it with graphene sheets by a facile self-assembly process. Compared with pristine MOFs, the composite showed a prolonged order-disorder transition and greatly enhanced electrochemical performances. During the lithiation/delithiation process, the bulk MOFs crystal particles were transformed into fine amorphous powders, which were protected by the graphene sheets from detaching from the electrical current collector. The enhancement of the electrochemical performances is ascribed to the effect of the synergy between the order-disorder transition in MOF particles and the addition of graphene sheets. The order-disorder transition remarkably increased the capacity of the composite from 60 to 400 mAh g^{-1} at a current density of 100 mA g^{-1} after 100 cycles. At the current density of 1000 mA g^{-1}, the composite experienced an order-disorder transition (activation process) in the first 500 cycles and then the capacity exhibited a decay of 0.02% per cycle in the subsequent 500 cycles, suggesting its high cycling stability. This work implies that the order-disorder engineering concept can be used to improve both the capacity and the cycling stability of anode materials with great volume changes.

Keywords

Lithium ion batteries; Anode; Metal-organic Framework; Order-Disorder Transition

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